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AN INEXPENSIVE AND EFFECTIVE METHOD FOR THE CONTROL OF RED ROOT DISEASE OF TEA

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In view of the prohibitive costs of controlling the Red Root Disease of tea caused by the fungus *Poria hypolateritia*, by fumigating with methyl bromide, an alternate method of control has been investigated. This method, found to be effective and much less expensive, involves the rehabilitation of *Poria* patches, cleaned in the usual manner, for a period of two years, without fumigation. At the end of this period tea is planted as usual, but is watered periodically with certain systemic fungicides for a period of one year after planting.

It has been found that whatever roots that are left behind at depths below 18" in the cleaning up process could be less than 1—1 1/2" in diameter and these have been found to disintegrate during the rehabilitation period. Chances of any residual infection getting onto young tea is prevented by watering the plants with the systemic fungicides for a period of one year. Further experiments are in progress to determine whether this period could be reduced to 9 or even 6 months.

INTRODUCTION

The tea plant is affected by many root diseases. In the up-country districts of Sri Lanka the most serious root disease is the Red Root Disease, caused by the fungus *Poria hypolateritia* Berk., and is of major economic importance to the tea industry. Plants attacked by root diseases are characterised by the sudden wilting of the foliage and death of the plant. Although the final death of the plant normally occurs in dry weather, wilting and death of affected plants can occur even during wet weather when there is no deficiency of water.

This disease, often known by its generic name *Poria* normally occurs at altitudes of over three thousand feet. A characteristic feature of the disease is the presence of mycelial strands (rhizomorphs) on the bark of the roots. These are white and soft when young but become red and tough and finally blacken with age. They may remain as distinct strands or become fused forming continuous sheets.

The disease is said to have originated from the stumps of jungle trees, which were not completely destroyed when tea was originally planted. The stumps of Dun trees, *Doona gardneri*, are said to have been hosts of this fungus. The disease is unable to survive in the absence of suitable host plants and after the disappearance of the jungle it survived mainly on tea and on the roots of plants like *Albizzia moluccana* and Dadaps. Fructification of the fungus, which is rather infrequent, is at the collar of the bush, as a bract with their red plates studded with minute pores.

The spread of the disease by air-borne spores has not been established and the main method of spread of infection has been observed to be by disposal of infected material.

At present the disease is successfully controlled by fumigation with methyl bromide after the affected bushes and two rows of healthy looking bushes surrounding them are uprooted (Shanmuganathan, 1965). The roots of the healthy looking bushes are examined for the presence of the *Poria* mycelium, and even if one bush is found to have the fungus, a further ring of healthy bushes are removed. All roots above pencil thickness are dug out by forking and all infected material are burnt on the spot to prevent the spread of the disease. The area thus cleaned is fumigated with methyl bromide at the rate of 1 lb/200 sq. ft. under a polythene tent. This fumigated area can be planted with tea after one week.

In view of the phenomenol increase in the cost of the chemical and other costs related to fumigation, an alternate method of control has been under investigation for the past few years. This method involves rehabilitation of the cleaned-up *Poria* patches for a period of two years with grasses, without fumigation. At the end of this period tea is planted in the usual manner, but watered periodically with certain systemic fungicides for a period of one year.

EXPERIMENTAL

Fungicides tested :

Benlate (benomyl), Tecto (Thiabendazole), Sicarol (Pyracarbolid), Bayleton (Triadimefon), Baycor (bitertanol), Tilt (Propiconazole), PP 969, Calixin (tridemorph).

Laboratory investigations :

To determine the *in vitro* toxicity of the fungicides to *P. hypolateritia*, the fungicides were incorporated at a range of concentrations into Difco potato-dextrose agar (PDA) cooled to about 40°C. The plates were inoculated with agar-disc inoculum of the fungus and the effect of the fungicides on the growth of the fungus was studied by measuring the radial growth of the mycelium.

Pot experiments :

Large Hawthorn pots were filled with fumigated soil and were planted with young tea plants of clone TRI 2024 which had been treated with the systemic fungicides a week to ten days before planting or with untreated plants. In some experiments the pots were inoculated with naturally infected tea roots while in others inoculation was with artificially infected tea roots. After the initial application, the fungicides were applied once in three months. After 1 1/2 - 2 years the inoculum were taken out and cultured in attempts to isolate the fungus.

Field experiments

Location, size and number of *Poria* patches

The experiments were carried out on the following five estates (see Table 1) :

Estate	*No. of patches*	*Size of patches*
Hauteville, Agrapatna	4	16' × 32' ; 14' × 24' ; 14' × 32' ; 14' × 36'
Diyagama West, Agrapatna	1	14' × 24'
Stonycliff, Kotagala	3	24' × 16' ; 32' × 16' ; 26' × 16'
Vellai Oya, Hatton	5	20' × 32' ; 28' × 28' ; 42' × 30' ; 30' × 40' ; 50' × 36'
Dunsinane, Punduloya	3	28' × 40' ; 24' × 40' ; 32' × 40'

Method of cleaning

The dead and dying bushes in the affected patches were uprooted along with two rows of healthy looking bushes surrounding them. The roots of healthy looking bushes were examined for the presence of *Poria* mycelium, and even if one bush was found to have the fungus, a further ring of healthy bushes were removed. The area thus uprooted always included two healthy bushes at every point on the perimeter. All bushes and other woody material uprooted during the cleaning operation were burnt on the spot. This was followed by forking the area to a depth of 18" - 24" and removing all roots living or dead - of tea, shade or jungle tree - of more than pencil thickness, all of which were burnt.

Treatment

The cleaned-up area was levelled and in three of the experiments the cleaned areas were planted with guatemala grass for two years before planting with tea. In the other experiments they were planted with tea within two weeks of cleaning-up. In one experiment, after uprooting the dead and dying bushes, the broken roots in the soil were not removed by forking.

For some experiments plants watered in the nursery with 250 ml of the fungicides, a week to ten days before planting were used while for the others the first treatment with the fungicides was given at the time of planting. Thereafter the plants were watered with the fungicides (250-300 ml/plant) once in 3-4 months up to one year from planting.

TABLE 1—*Schedule of experiments carried out on Poria control*

Location		*Date of uprooting tea*	*Date of planting*		*Clone*	*Number of plants/ treatment*	*No. of casualties Aug./Sept. 1986*
			Grass	*Tea*			
Hauteville	1	July 1980	July 1980	Aug. 1982	2025	Control-32	1
						Benlate-16	—
						Tecto-16	—
,,	2	July 1982	—	Aug. 1982	2025	Control-14	3
						Benlate-7	2
						Tecto-7	2
,,	3	July 1980	July 1980	Aug. 1980	2025	Control-26	1
						Benlate-13	—
						Sicarol-13	—
,,	4	Nov. 1982	—	Dec. 1982	2025	Control-18	3
						Benlate-13	1
						Sicarol-18	—

Location		Date of uprooting tea	Date of planting		Clone	Number of plants/ treatment	No. of casualties Aug./Sept. 1986
			Grass	Tea			
Diyagama West		Sept. 1982	—	Oct. 1982	2025	Control-22	6
						Bayleton-11	1
						Sicarol-18	1
Stonycliff	1	Oct. 1982	—	Nov. 1982	CY 9	Control-23	6
						Benlate-23	5
,,	2	Oct. 1982	—	Nov. 1982	CY 9	Control-23	4
						Sicarol-23	1
,,	3	Oct. 1982	—	Nov. 1982	CY 9	Control-23	2
						Tecto-23	2
Vellai Oya	1	June 1983	—	July 1983	2025	Control-40	4
						Sicarol-20	1
						Bayleton-20	1
,,	2	June 1983	June 1983	Nov. 1984	2025	Control-40	—
						Baycor-20	—
						Sicarol-20	—
,,	3	June 1983	—	June 1983	N 2	Control-74	8
						Bayleton-37	2
						Sicarol-37	—
,,	4	June 1983	—	June 1983	N 2	Control-100	9
						Benlate-25	4
						Bayleton-25	1
						Sicarol-25	—
						Baycor-25	—
,,	5	June 1983	—	July 1983	N 2	Control-80	6
						Benlate-20	3
						Bayleton-20	1
						Sicarol-20	—
						Baycor-20	—
Dunsinane	1	Nov. 1982	—	Dec. 1982	K 145	Control-80	6
						Bayleton-40	1
						Sicarol-40	1
,,	2	Dec. 1983	Roots not removed	Jan. 1984 .	2025	Control-60	14
						Bayleton-30	2
						Sicarol-30	1
,,	3	June 1985	—	July 1985	2025	Control-60	—
						Baycor-20	—
						Calixin-20	—
						Tilt-20	—

The fungicides were used at the following concentrations :

Benlate	—	0.05% and 0.1%
Tecto	—	0.1% and 0.2%
Sicarol	—	0.15%
Bayleton	—	0.15%
Baycor	—	0.15%
Calixin	—	0.2%
Tilt	—	0.2%

The other details of the experiments are given in Table 1.

Allocation of treatments

Since the infected bushes and hence the infected roots are not uniformly distributed in the soil in the *Poria* patches, the allocation of the treatments were carried out as shown in Figure 1. Planting holes were dug at the spacing of 4' x 2' in the demarcated patch. For example, if there were 120 holes and two treatments were to be applied in this particular patch, half of them, i.e. 60, were planted with untreated plants. In the other half 30 holes were used for each treatment. Each treatment was alternated with the controls.

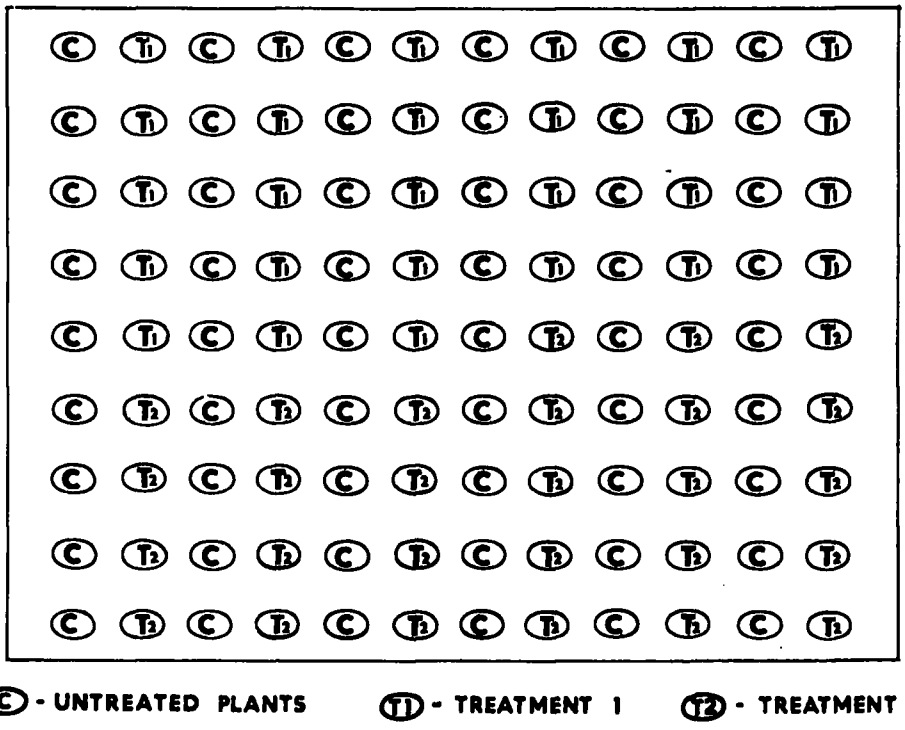

Fig. 1 — Diagram to show the allocation of treatments in Poria control experiments.

RESULTS

In the *in vitro* trials it was found that all the fungicides tested inhibited the radial growth of the *Poria* mycelium except Benlate and Tecto. The other fungicides completely inhibited the growth of the mycelium at very low concentrations.

Benlate and Tecto were not effective in the pot experiments as well. Plants treated with these fungicides and the untreated plants became infected and died subsequently. The plants treated with the other fungicides did not become infected. We were unable to isolate the fungus from the inoculum from the pots treated with the other fungicides. The fungus was readily isolated from the control pots and from the pots treated with Benlate and Tecto.

In the field experiments (Table 1) there were number of deaths due to *Poria* in the untreated plants and in the plants treated with Benlate and Tecto. There were few casualties in the Bayleton treated plants. Only two or three plants died in the Sicarol treatments. These results were obtained from the plants of the unrehabilitated patches. But in the patches rehabilitated with grass for two years there were only two casualties in the untreated plants and none in the treated plants, not even in those treated with Benlate and Tecto. In the experiment where the roots were not removed by forking there were a number of casualties in the control pots and comparatively very few in the treated plants. In the experiment that was commenced in July 1985 at Dunsinane Estate, Calixin and Tilt were also tested along with Baycor. There were no casualties up to the middle of November, 1986.

DISCUSSION

Benzimidazole fungicides are generally not effective against Basidiomycetes and therefore it is not surprising that Benlate and Tecto were not effective against *Poria*. The other fungicides tested were effective against the disease. Although fungicide treatments alone gave adequate control, it was found that fungicide treatment combined with rehabilitation gave excellent control of the disease. It was found that if the infected roots are not removed the control afforded by the fungicide is less because of the high inoculum potential. Therefore for the successful implementation of this method of control, first and foremost, it is important that all infected roots above pencil thickness be removed by forking. Uprooting the bushes with a winch will ensure that all large roots are removed without damage. Rehabilitation with grass for a period of two years serves a double purpose. Firstly, the small roots left in the soil at the time of uprooting the tea disintegrates during this period of two years and without any food source or an alternate host the fungus is unable to survive in the soil. Secondly the tea that has become infected with *Poria* has existed on that soil for over seventy five years and the soil would have become eroded and compacted and any form of rehabilitation will help to improve the physical structure of the soil and its organic matter content and hence the infilled plants in these rehabilitated *Poria* patches will grow better. Watering the plants with the systemic fungicides at the time of planting and at 3-4 month intervals for a period of 9-12 months will protect the plants from infection if there is any inoculum left in the soil. Experiments are in progress to find out whether it would be possible to reduce the number of fungicide applications to three or even two.

It is now accepted that all patches that are to be infilled should be rehabilitated for a period of two years even if they are fumigated. Therefore the combining of this cultural practice with the use of systemic fungicides will be a much cheaper and effective method for the control of *Poria*. The comparative costs for the control of *Poria* are given in Table 2. The cost of uprooting and cleaning the diseased patches will be the same for both methods of control, whereas the cost of employing the new method will be very much cheaper than the cost of fumigation with methyl bromide. The use of this method would result in the saving of Rs. 37,000-40,000 per hectare.

TABLE 2—*Comparative costs of Poria control methods*

		Rs.
Cleaning by hand		
Uprooting 25 bushes per 200 sq. ft. – 1 1/2 labourers		37·50
Deep-forking 200 sq. ft. and removing roots – 1 1/2 labourers		37·50
		75·00
Cost per acre of *Poria* infested land	Rs. 16,350	
Cost per hectare of *Poria* infested land	Rs. 40,384	
Fumigation with Methyl Bromide		
Cost of Methyl Bromide – 1 lb/200 sq. ft.		80·00
Cost of polythene sheet and labour for application per 200 sq. ft. 350 + 6.25		20·25
	25	100·25
Cost of fumigation per acre	Rs. 21,854	
Cost of fumigation per hectare	Rs. 53,980	
Alternate method – treatment with systemic fungicides		
Cost of fungicide and labour per 200 sq. ft. (per application)		Rs. 7·80
Cost of fungicide and labour per acre (per application)	Rs. 1,700	
Cost of fungicide and labour per hectare (per application)	Rs. 4,200	
Cost of fungicide and labour per hectare (for 3 applications)	Rs. 12,600	
Cost of fungicide and labour per hectare (for 4 applications)	Rs. 16,800	

Savings – Rs. 37,000 to Rs. 41,000 per hectare

Note : (1) Materials and labour for fumigation is calculated as follows :

$$\frac{\text{Cost of Polythene sheet}}{\text{No. of times of use}} + \text{2 h labour}$$

(2) Cost per application per 200 sq. ft. is calculated on the basis of the cost of Baycor + 1 h labour in the case of treatment with systemic fungicides.

CONCLUSION

Red root disease of tea can be successfully and economically controlled by combining normal cultural practices with the limited use of systemic fungicides. For this method to be successful it is absolutely necessary that all woody materials above pencil thickness be removed by deep forking and that the area thus cleaned be rehabilitated with grass for a minimum period of two years before being planted with tea.

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REFERENCES

Shanmuganathan, N. (1965). Control of *Poria* root disease with methyl bromide. *Tea Q.* 36, 144-150.